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ABSTRACT

This research brief describes a study of the readiness for high school of eighth-graders who participated in the Southern Regional Education Board's (SREB) Middle Grades Assessment in spring 2000. The assessment included testing in reading, math, and science, and surveys of students and teachers. Following the 2000-01 school year, SREB gathered course-assignment and performance data on about 3,100 students--about 60 percent of the original sample--who had completed the ninth grade. Following are some of the key findings. Many students who expected to go to college were not taking the necessary courses in high school. Enrollment in more demanding courses did not result in more failures. Studying algebra or pre-algebra in the middle grades led to enrollment in higher level math courses in high school and did not increase failure rates. Teachers matter enormously; students in the middle grades who had teachers as advisors were more likely to have had educational goals and plans for high school. The report concludes with recommendations for leaders in middle schools and high schools to help students succeed in college-preparatory classes, and for states and districts to improve the transition from middle grades to high school. (WFA)

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Middle Grades to High School: Mending a Weak Link. Research Brief.

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Gene Bottoms

2003

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HIGH SCHOOLS THAT WORK

Research Brief

SREB

MAKING MIDDLE GRADES WORK

MAKING SCHOOLS WORK

Middle Grades to High School: Mending a Weak Link

by Sondra Cooney and Gene Bottoms

Take 100 ninth-graders with similar characteristics and test scores in the eighth grade. Place 50 in higher-level ninth-grade courses. Place 50 in lower-level courses. What happens? If you said fewer students fail in the higher-level courses, you are correct. Please read on.

The Southern Regional Education Board conducted a follow-up study of nearly 3,100 students from 44 middle schools and 38 high schools and found:

Ninth-graders who are placed in higher-level courses have a lower failure rate than students with similar characteristics who are placed in lower-level courses.

This fact begs the question:

Why do we continue to place large numbers of students in lower-level courses where they have little or no chance of gaining the skills and knowledge they need to succeed?

Here is what we know …

Our studies suggest that students who are assigned to higher-level, more challenging work are more successful in high school.

We also know that about one in five students in SREB's network of middle grades schools fails at least one course in the ninth grade, and about 10 percent do not earn enough credits to stay on track for graduation with their classmates.

Clearly, raising the achievement of high school students requires three actions:

1. **Students must be challenged to perform at high levels.**
2. **Students must be prepared before they enter ninth grade to meet these challenges.**
3. **Students must be given the extra help and extra time they need to succeed.**

Simply put, they must be ready for high school.

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Goal

The SREB middle grades goal is to ensure that all students perform at the basic level in reading, mathematics and science on the NAEP-based SREB Middle Grades Assessment and to increase the percentage of eighth-graders who perform at the proficient level and who leave eighth grade ready for college-preparatory work in high school.

Key Findings

- Many students who expect to go to college are not taking the necessary courses in high school.
- Some schools enroll many more students in college-preparatory courses than others. The difference is not explained by differences in students or demographics.
- Enrollment in more demanding courses does not result in more failures. In fact, the evidence suggests that challenging content results in lower failure rates. It appears that many students in all kinds of schools can handle more challenging intellectual assignments than schools are willing to give them.
- Taking algebra or pre-algebra in the middle grades leads to enrollment in higher-level mathematics courses in high school and does not increase failure rates.
- Middle grades schools that successfully prepare students for college-preparatory courses in ninth grade provide extra help and link students with an adult mentor. Successful schools come in many sizes, and their students vary by ethnicity and socioeconomic status.
- Teachers matter enormously; middle grades students who have teachers as advisers are more likely to have educational goals and plans for high school.
- There are simple steps that middle grades and high schools can take to make sure almost all students will be successful in college-preparatory courses.

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How Did We Learn This?

SREB followed up on a group of eighth-graders who participated in our Middle Grades Assessment in the spring of 2000. The Assessment included testing in reading, mathematics and science and surveys of both students and teachers. Following the 2000-2001 school year, we gathered course-assignment and performance information on about 3,100 students — about 60 percent of the original sample — who completed their ninth-grade year in high school.

To measure "readiness for high school," we examined the grades students earned in ninth-grade college-preparatory courses. Students who earned a grade of "C" or above were considered ready for high school.

What Happens to Students in Ninth Grade?

SREB, assisted by schools and districts in our middle grades network, collected data on the English, mathematics and science courses students took as ninth-graders and the grades they received for each course.

In Table 1, "All Schools" refers to every middle grades school that completed our follow-up study. These 3,098 students moved into high school from 44 schools in the SREB middle grades network. **"High Enrollment Schools" refers to the 25 percent of middle grades schools that had the greatest percentage of students in ninth-grade college-preparatory classes at their receiving high school(s).**

Table 1
Percentage of Students Enrolled in College-preparatory Courses
in Ninth Grade and Their Success Rates

College-preparatory Courses (C-P)	All Schools		High Enrollment Schools	
	Enrolled in C-P	Success Rate	Enrolled in C-P	Success Rate
C-P English 9	25%	91%	56%	86%
Other advanced English	2%	92%	3%	92%
C-P Algebra I or integrated mathematics	31%	75%	56%	72%
Algebra II or other advanced mathematics	5%	90%	15%	95%
Geometry	15%	91%	15%	84%
C-P physical science	5%	81%	21%	79%
C-P biology	3%	94%	13%	93%
Other advanced science	1%	78%	4%	78%

Table 1 shows that schools which enrolled more students in college-preparatory classes had success rates similar to schools that enrolled significantly fewer students in higher-level classes. Enrolling significantly more ninth-grade students in higher-level classes does not raise failure rates in these network schools. It **does** raise student achievement.

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What Experiences in Eighth Grade Are Linked to Ninth-grade Performance?

A comparison of our eighth- and ninth-grade data reveals three middle grades experiences associated with students who take and succeed in higher-level courses in grade nine.

These experiences are:

- studying "something called algebra" in the middle grades;
- reading a **great number** of books in grade eight; and
- expecting to graduate from college.

Studying "something called algebra"

Across all schools, 62 percent of the students who said they had a course with "algebra" in its title during the middle grades were enrolled in college-preparatory mathematics in ninth-grade. Eighty-five percent of these students earned a "C" or above. High enrollment schools enrolled 82 percent of students who had algebra in the middle grades in college-preparatory mathematics courses. They had virtually the same success rates as schools with lower enrollment rates. Clearly, students who begin algebra earlier are more likely to succeed in an accelerated mathematics curriculum if high schools choose to enroll them in this curriculum.

Table 2

Comparision of Enrollment and Success Rates of Ninth-grade Students in College-preparatory Mathematics at All Schools and at High Enrollment Schools

Exposure to Algebra in the Middle Grades	Experiences of Ninth-graders in College-preparatory Mathematics	
	All Schools	**High Enrollment Schools**
Algebra in Middle Grades		
Ninth-grade C-P math enrollment	62%	82%
Ninth-grade C-P math success rate	85%	81%
No Algebra in Middle Grades		
Ninth-grade C-P math enrollment	35%	68%
Ninth-grade C-P math success rate	73%	66%

Only 35 percent of students who did not have something called "algebra" in the middle grades were enrolled in higher-level mathematics courses in ninth grade — with a 73 percent success rate. High enrollment schools assigned 68 percent of students without middle grades algebra to college-preparatory mathematics courses, and about two-thirds of those students earned a "C" or above.

These findings require middle grades and high schools to ask some hard questions about the mathematics curriculum and student placement practices:

- Why aren't all eighth-grade students enrolled in either pre-algebra or Algebra I?
- Why aren't all students who studied algebra in the middle grades enrolled in ninth-grade college-preparatory mathematics classes?
- What criteria are schools using to assign students to higher-level mathematics in ninth grade?
- What can high schools do to reduce failure rates in ninth-grade mathematics and to help more students meet the standards of higher-level courses?

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Reading a lot of books in grade eight

Students who read more in the eighth grade are more likely to be enrolled in college-preparatory English courses in ninth grade.

SREB's reading goal for middle grades students is at least 25 books per year across the curriculum. Data from *High Schools That Work* indicate that improved performance in high school English is associated with reading at least 10 books each year.

Table 3 shows that, in all schools, only 30 percent of students who reported reading 11 books or more in the eighth grade were enrolled in college-preparatory English in ninth grade. In high enrollment schools, more than twice as many students who read the same number were in high-level courses.

High enrollment schools also encourage more students who report reading very little during grade eight to enroll in college-preparatory English, and they provide support to help them complete the course successfully.

Table 3

Comparision of Enrollment in College-preparatory English Courses in Ninth Grade and the Number of Books Read in Eighth Grade at All Schools and at High Enrollment Schools

Number of Books Read in Eighth Grade	Enrollment in College-preparatory English Courses in Ninth Grade	
	All Schools	**High Enrollment Schools**
0-2 books	14%	31%
3-10 books	27%	59%
11 books or more	30%	66%

These findings require middle grades and high schools to ask some hard questions about the English curriculum and student placement practices:

- Why aren't all eighth-grade students reading a significant number of fiction and non-fiction books in preparation for the reading demands of high school?
- Why aren't all students who have read a significant number of books in the middle grades enrolled in college-preparatory English classes in ninth grade?
- What criteria are schools using to assign students to higher-level ninth-grade English courses?
- What can schools learn from the high enrollment schools in this study about placing students who read fewer books in ninth-grade college-preparatory English classes and providing the support they need to succeed?

Expecting to graduate from college

Surveys have found that students' educational expectations generally are higher than their teachers' or parents', especially when it comes to college enrollment and graduation. Data from the Middle Grades Assessment in 2000 show that high-performing students are much more likely to talk with counselors several times about which classes to take in high school. Low-performing students who need the most help in developing educational goals are the least likely to have received such help. In fact, about 20 percent of low-performing students report that they do not know how much education they will complete. Only seven percent of high-performing students report the same.

This study shows that about half of eighth-grade students who expect to graduate from college are not enrolled in the college-preparatory mathematics courses they need. The percentages are even higher in English and science.

The high enrollment schools in our study have significantly more students in all college-preparatory classes. The schools in this group include large schools, schools with high percentages of minority students and schools eligible for Title I federal funds for the disadvantaged. **These are the schools that align student course-taking patterns with student aspirations and with rising demands that students have quality high school experiences.**

Adults in high enrollment schools clearly are setting higher expectations for students entering grade nine. Too many other schools are allowing students to pursue courses that will prepare them only for remediation in college and for failure on employer examinations.

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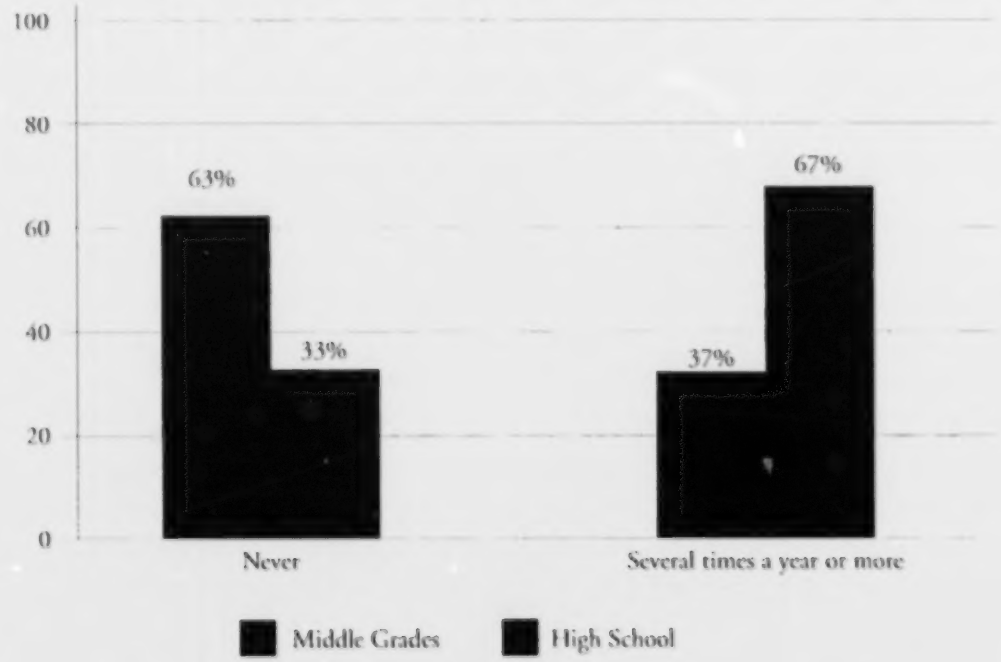
Table 4
Comparison of Eighth-graders Who Expect to Graduate from College and Are Enrolled in College-preparatory Courses in Ninth Grade at All Schools and at High Enrollment Schools

College-preparatory Courses	Percentage of Eighth-graders Who Expect to Graduate from College and Are Enrolled in College-preparatory Courses in Ninth Grade	
	All Schools	**High Enrollment Schools**
English	29%	62%
Mathematics	54%	80%
Science	11%	43%

These findings require middle grades and high schools to ask some hard questions about the expectations for college and about ninth-grade course assignment practices by high schools:

- Why are so many students who expect to graduate from college not enrolled in the college-preparatory courses they need to be successful in higher education?
- Among schools with similar student bodies, why do some have significantly more students in college-preparatory classes?
- Why are middle grades counselors and teachers spending so little time counseling students who have no educational goals or plans about the need for college-preparatory courses in high school?

Exhibit 1
Teachers Who Assist Parents/Students in Developing a High School Plan



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What Can Middle Grades Schools Do to Prepare More Students for High School and College?

Middle grades students who have teacher-advisers are more likely to have educational goals and plans for high school and beyond. Schools that use teachers as advisers and mentors can make sure that students and parents receive timely information about careers and college-preparatory programs in high school. This support is most important for lower-achieving students and students less likely to get help and support at home.

SREB research shows that lower-achieving students — who need the most guidance — are the least likely to receive it. (See *Closing Gaps in the Middle Grades.*) Teachers who agree to guide students can make an enormous difference in the decisions students make. And the earlier that guidance starts in the middle grades, the more students and their families will understand the importance of beginning to prepare for college well before high school begins.

What Are the Characteristics of Schools that Prepare More Students for College-preparatory Courses and that Enroll Greater Percentages of Students in These Courses During the Ninth-grade Year?

Many people assume middle grades schools that prepare a high percentage of students for challenging work in high school must be in well-to-do neighborhoods with mostly white students. Our data suggest otherwise.

In our study, middle grades schools with larger percentages of students going on to college-preparatory courses in ninth grade ranged in size from fewer than 100 students to 1,000 or more. The schools' ethnic compositions ranged from about 44 percent white to 100 percent white. Over half of the schools received Title I funding, and the percentage of students eligible for free or reduced-price lunch ranged from 23 percent to 74 percent.

Among middle grades principals in schools that prepared more students for high school, 46 percent reported that every student in the school received reading instruction. The time spent on English/language arts instruction ranged from 45 to 75 minutes a day. Students spent less time in mathematics and science classes; instructional time ranged from 31 to 60 minutes.

Middle grades schools that successfully prepared students for challenging high school work were more likely to report that students received extra help and extra time. These schools were more likely to provide extra help in mathematics and science than in English/language arts.

Extra-help programs include tutoring, mentoring through such programs as "Big Brothers, Big Sisters," after-school or before-school sessions that extend the school day, double sessions of academic courses, and summer school sessions.

Fifty-nine percent of middle grades schools that were successful in preparing many students for high-level courses provided three or more extra-help programs. Among schools whose students were less likely to enroll in college-preparatory courses, only 39 percent offered that much help. The more successful schools were more likely to link students with an adult or peer mentor.

Through school and classroom observations, the SREB staff, experienced educators, parents and others have identified the following strengths in middle grades schools that prepare more students for high school:

- These schools have strong leaders who set clear goals and priorities, establish a school climate conducive to learning, organize the staff for improvement, and provide support for both teachers' and students' needs.
- Teachers work together in teams and across grades to ensure that all students are known and that their needs are met; teachers are provided time to plan and to discuss the results of their plans.
- These schools expect their students to achieve; they commit extra time and extra help to ensure that students meet high standards and grade-level expectations.
- Student-centered instructional activities such as working with a partner or a group, integrated learning such as using mathematics skills in other classes, and hands-on learning such as science experiments and laboratories are more likely to be found in middle grades schools whose students are ready for higher-level work.

What Can High Schools Do to Increase Enrollment in College-preparatory Courses?

Like the middle grades schools in our study, successful high schools failed to fit into any stereotypical mold. Our data show that high-poverty schools were "as likely" to enroll a higher percentage of ninth-graders in college-preparatory classes as schools in more well-to-do communities.

These successful high schools varied in size from slightly more than 300 students to almost 1,500 students. The racial composition of the schools varied from 11 percent white to 99 percent white. While only three of the high schools received funding from the federal Title I program (which is less prevalent in high schools), the percentage of students eligible for free or reduced-price lunch ranged from 14 percent to 84 percent.

High schools that enrolled the most students in college-preparatory classes were more likely to require students with a grade of "C" or lower to attend extra help sessions (62%) than schools which enrolled fewer students in higher-level classes (36%). These high enrollment schools also provide transportation to extra-help sessions.

High enrollment high schools were more likely to use a traditional instructional schedule (31% with class periods between 45-50 minutes) than those schools with lower enrollment in college-preparatory classes (21%). However, the majority of both groups of schools used a type of block schedule containing instructional periods of 85 to 90 minutes in length.

All but three of the high enrollement high schools had participated for some time in SREB's *High Schools That Work* initiative. A major goal of *HSTW* is to increase the percentage of students enrolled in higher-level academic courses and to give students the extra help they need to succeed in them.

Characteristics of High Enrollment Schools

Through school and classroom observations, the SREB staff, experienced educators, parents and others have identified the following strengths in high-enrollment high schools:

- These schools have raised expectations for student achievement by increasing the number of credits needed for graduation to at least 26 Carnegie units and to as many as 30 units. They have phased out lower-level courses and the general track while increasing the number of Advanced Placement and postsecondary courses offered with dual credit for high school and college. Some require a senior project, an academic career major, or a career certification examination.
- Examples of challenging student assignments are present in these high schools, including integrated learning activities. They create cooperative learning opportunities, use high-engagement teaching strategies and involve students in real-world applications.
- Guidance and advisement programs have teachers and administrators as advisers who help develop multi-year educational plans and review them annually with students and their families. Most schools have implemented or are planning transition activities between the high school and its middle grades "feeder" schools.
- Strong leaders have defined and communicated clearly the expectations for students and work with faculties to support the expectations. These leaders build community support for higher expectations and participate in professional development that meets students' and teachers' needs.

How Are Middle Grades Students Placed In Ninth-grade Classes?

Ninth-grade placement practices vary, but the predominant pattern is for high school counselors to spend a day and/or evening at the middle grades school filling out individual high school schedules for each student.

Counselors have access to students' grades and test information, and in some schools these high school representatives will have met with middle grades counselors to go over appropriate placements for students — especially those with special needs or unusual circumstances.

The things that really separate the placement practices of high enrollment schools from lower-enrollment schools are communication and expectations.

Some schools are much more aggressive in educating students and parents about courses with challenging content. Through demonstrated success, administrators and teachers have more confidence in the ability of all students to succeed in higher-level coursework, and they communicate this confidence to students and parents.

Lower-enrollment schools continue to fit the curriculum to the perceived ability of students, while high enrollment schools recognize that well-supported students can complete a more challenging curriculum and place them accordingly.

Are high-enrollment schools justified in making this decision? The data say "yes."

Results from our end-of-eighth-grade Middle Grades Assessment test were compared to success rates in both higher- and lower-level ninth-grade classes in three subject areas. We gave particular attention to those students who were not successful because critics of higher standards and accountability tend to focus on dropout and failure rates.

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In Table 5, students are compared by their eighth-grade test results and the grades they earned in their ninth-grade classes.

Students who took our NAEP-based eighth-grade reading test and scored in the lowest two quartiles were about twice as likely to fail ninth-grade English if they were placed in a lower-level English course rather than a college-preparatory course. Only students with mathematics and science test scores in the lowest quartile had a slightly higher failure rate in grade nine if they were enrolled in higher-level courses.

Clearly, enrollment in more demanding courses does not result in more failures. In fact, the evidence suggests that challenging content, bolstered by a quality student support system, produces lower failure rates. Many students can handle more challenging intellectual assignments than many schools are willing to give them.

These results require district leaders to ask: How are school leaders, counselors and teachers placing students in grade nine classes? Are such factors as attendance, background and behavior determining placement? Do placement factors fail to recognize the potential of many students?

Students who can achieve but who may have other problems seem to be placed almost automatically in lower-level classes in some schools. Such inappropriate placement may result in even poorer attendance, more behavior problems and higher dropout rates.

High school administrators and faculty need to answer these questions:

- Why do similar students have a lower failure rate in higher-level courses than in lower-level courses?
- Do lower-level courses expect so little that students stop trying? Do they come to believe they cannot accomplish anything worthwhile and that school does not matter for them?
- Are teachers sorted so that those who are the most experienced and knowledgeable teach the "best students," while newer or weaker teachers are assigned to lower-level courses?
- Do students in higher-level courses get more help and support?
- Do students in higher-level courses perform at a higher level to match expectations?
- Are materials used in college-preparatory courses more interesting?
- Do teachers receive the professional development they need to apply research-based teaching strategies that can help lower-achieving students meet the demands of higher-level courses?

Answers to these questions should reveal whether the school has the climate and culture necessary for student success. Schools that have high expectations, that demand students' best efforts, and that provide extra help and support to boost student confidence have students who succeed. Likewise, schools that set high expectations for teachers, demand their best efforts and support them as professionals have faculties who expect more of students and who help them achieve higher standards.

Table 5

Percentage of Ninth-grade Students Earning a "D" or an "F" in College-preparatory and Lower-level Courses by Eighth-grade Test Achievement Quartiles

	Lowest Quartile 1	2	3	Highest Quartile 4
English Courses				
College-preparatory English	23%	16%	10%	4%
Lower-level English	47%	31%	23%	8%
Mathematics Courses				
College-preparatory mathematics	47%	31%	16%	9%
Lower-level mathematics	42%	37%	25%	16%
Science Courses				
College-preparatory science	48%	23%	13%	5%
Lower-level science	44%	33%	16%	8%

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How Can Almost All Students Succeed in College-preparatory Classes?

Middle grades and high schools must work together to ensure that almost all students complete college-preparatory courses in grades nine and 10. At a minimum, all students should complete college-preparatory English in grades nine and 10 and college-preparatory algebra and geometry by the end of grade 10. Students and their families need information early in the middle grades about the importance of these higher-level courses to college and career aspirations.

Here are some important actions that schools can take to accelerate student success and increase the percentage of students completing at least two years of college-preparatory English and mathematics in high school.

Middle grades schools can:

- change the mathematics curriculum so that all students complete either pre-algebra or Algebra I successfully by the end of eighth grade;
- expect all students to read 25 books or the equivalent across the curriculum each year in the middle grades;
- identify students by grade seven who may have difficulty completing a challenging curriculum in grade nine, and take steps to increase their instructional time in reading, English and mathematics;
- place struggling students in an accelerated curriculum with the best teachers;
- take steps to provide all middle grades students in grades seven and eight with teachers who have at least a minor (preferably a major) in the content area(s); and
- work with students and families to educate them about which courses lead to greater achievement and success, and help students and their families develop a five-year educational plan.

High schools can:

- provide catch-up courses, double periods and extra help for students who need extra instruction and time to meet higher course standards;
- re-think placement practices and take steps to increase annually the percentage of entering ninth-grade students assigned to college-preparatory English, mathematics and science courses;
- take immediate steps to enroll at least the same percentage of incoming ninth-graders in college-preparatory courses as high-enrollment schools do;
- teach all students to the same challenging standards, provide extra help and extra time for those who need it, and require students who earn below a "C" at any time to get extra help to strengthen their performance; and
- appoint a special committee composed of teachers to study current placement practices. (The committee can visit high schools that enroll a higher percentage of ninth-graders in college-preparatory courses and should be responsible for developing a plan to enroll more students in higher-level classes while reducing failure rates.)

Together, middle grades and high school leaders can:

- organize vertical teams of middle grades and high school teachers in English, mathematics, science and social studies to align curriculum and performance standards to the level needed for challenging high school studies;
- work together to orient families, middle grades students and teachers about ever-tougher high school graduation requirements, rising demands in the workplace and the importance of a challenging program of studies in high school; and
- convene panels of high school and middle grades teachers in language arts, mathematics and science to identify what students need to know and be able to do to be prepared for college-preparatory work in grade nine. For example: What skills do students need to be successful in ninth-grade mathematics?

(See page 12.)

What Can States and Districts Do to Improve the Transition from Middle Grades to High School?

Given the powerful evidence that almost all well-supported students can rise to the challenge of high expectations, state leaders cannot afford to leave decisions about middle grades preparation and high school placement entirely up to local schools.

Here are actions state decision-makers and policy leaders can take to ensure that the "weak link" between the middle grades and high school is mended and that the opportunities for students to meet the demands of college and the 21st century workplace are increased exponentially:

- Develop research-based readiness indicators for success in challenging high school studies.
- Require districts and schools to report annually the percentage of students successfully completing challenging courses in middle grades and high school.
- Conduct curriculum audits in low-performing middle grades and high schools to assess the extent to which higher quality and an increased quantity of academic instruction are available to more students each year.
- Require high schools and their sending middle grades schools to work together on educating families and students about what students need to know and be able to do to succeed in a challenging high school curriculum.
- At a minimum, require a one-on-one planning session for all students and their parents for the purpose of planning a challenging high school program that will prepare students for both college and employment.
- Require each high school to develop a follow-up plan with their sending middle grades schools that assesses annually the percentage of students who successfully complete two years of college-preparatory English, mathematics and science courses by the end of grade 10.
- Provide guidelines on how middle grades and high school leaders can work together to get more students ready for high school — and how they can successfully enroll more students into higher-level courses in grade nine while reducing course failures and dropout rates;
- Provide middle grades schools with examples of interventions that have proven successful in advancing student achievement and readiness for high school.
- Require and fund high schools to identify eighth graders who are not ready to do college-preparatory English and mathematics in grade nine, and provide a rich summer school experience. If necessary, schools should provide continuing work and support during the first semester of ninth grade aimed at catching these students up and enrolling them in more challenging high school work by the second semester of ninth grade.

To accomplish this agenda, school districts must select teachers with a record of success in advancing student achievement and provide the materials, technology and time needed to plan and conduct quality learning experiences. Districts can demonstrate the effectiveness of their actions by a report to the state and the community that describes the results of their transition programs — successful outcomes, challenges remaining, and changes planned to improve the efficiency and effectiveness of the transition program.

We can no longer be satisfied with a "basic education" for most students. Our data clearly demonstrate that many more students can succeed in college-preparatory-level courses. Schools of every kind are doing it, so we know it can be done. We cannot continue to accept excuses from schools that are willing to sacrifice student success to avoid the hard work of change.

12 Things Students Should Know and Be Able to Do to Be Ready for College-preparatory Mathematics

- Read, write, order and represent in a variety of forms: integers, fractions, decimals, percents and numbers written in scientific and exponential notation
- Add, subtract, multiply and divide integers, fractions, decimals, percents and numbers written in scientific and exponential notation with and without the aid of technology
- Determine greatest common factors, least common multiples and prime factorization
- Use ratios and proportions to describe situations and solve multi-step problems
- Draw and describe different types of angles, polygons and lines using their defining properties and appropriate tools
- Measure and calculate length, area, perimeter, surface area and volume using appropriate units, tools, techniques, formulas and levels of accuracy
- Understand and apply the Pythagorean relationship to solve problems
- Gather, present and interpret data
- Determine the number of ways an event can occur and the associated probabilities
- Simplify algebraic expressions and solve equations using substitution, the correct order of operations, grouping and properties of operations
- Represent, analyze, generalize and extend a variety of patterns with tables, words and symbolic rules
- Understand the concept of functions and represent them algebraically and graphically

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